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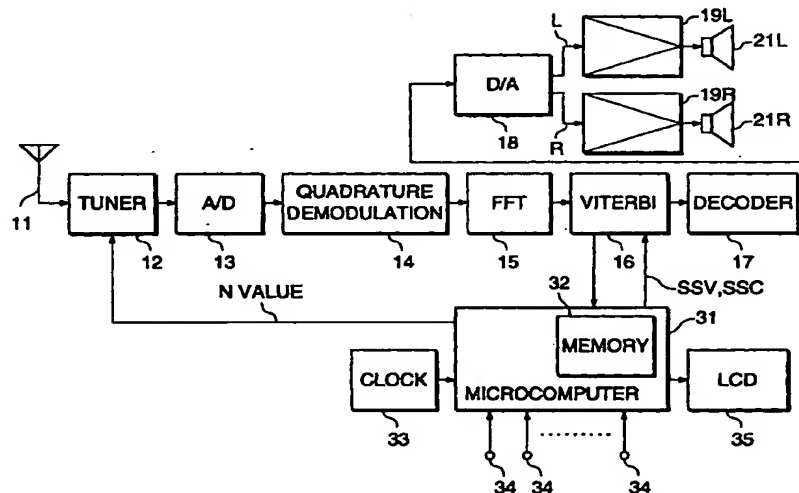
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(54) Receiver for receiving Digital Audio Broadcast DAB

(57) In digital audio broadcasting receiver for broadcasting a plurality of program groups and program data showing program contents in each group among a plurality of said program groups with one broadcast signal, the history table of the frequency data for receiving the broadcast signal and data indicating the service is provided. During the reception of broadcast, the data of the history table is retrieved with the data indicating the

desired service. When the relevant data is detected as a result of this retrieval, the frequency data corresponding to the relevant data is extracted from the history table. The receiving frequency is set to the frequency indicated by this extracted frequency data and the desired service is then selected.

FIG.1



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Description

[0001] The present invention relates to a digital audio broadcasting (DAB) receiver. In Europe, there has been performed digital audio broadcasting (DAB) which conforms to the Eureka 147 Standard).

[0002] This DAB can simultaneously broadcast up to 64 sets of digital audio signals and digital data by employing the specifications of: transmission bandwidth: 1.5 MHz, modulation system: orthogonal frequency division multiplex (OFDM), and data compression of audio signal: layer II of MPEG audio.

[0003] Therefore, in the DAB, program broadcast is performed in the hierarchical structure, for example, as illustrated in Fig. 7. Namely, DAB uses the transmission band of 1.5 MHz for a channel as explained above but this transmission channel is called "ensemble" and this "ensemble" is selected by tuning the transmission frequency to the centre frequency of this ensemble.

[0004] This ensemble is divided into the groups called "services". In the case of Fig. 7, the ensemble is divided into four services. This service is further divided to several "service components" and each service component is composed of the digital audio signal or digital data, forming a program.

[0005] In this case, a service corresponds to one broadcast station of the FM broadcast. For example, the services are used in such a manner that the first service component of the first service broadcasts a soccer game of the first place (program 1A) and the second service component broadcasts the soccer game of the second place (program 1B),

[0006] Moreover, the ensemble is given the identification code called the "ensemble ID" and the data of this ensemble ID is also transmitted. In addition, the data which is called as "program type" to indicate such service genre, for example, as illustrated in Fig. 8 is also transmitted to the service. Moreover, the service component is given the serial number in the respective services and this serial number is also transmitted.

[0007] Accordingly, it is possible to enjoy a program of DAB by selecting the ensemble (frequency), then selecting one service (group) among a plurality of services included in this ensemble and then selecting the target service component (program) from the selected service.

[0008] As explained above, since the services to be broadcast by the DAB is accompanied by a program type indicating the genre of service, the service of desired genre can be retrieved and received using the program type as a keyword.

[0009] In this case, however, format of ensemble can be changed as desired by a broadcast station. For example, in one authorized application method, the service 1 is prepared only when a soccer game is carried out and the soccer game of each place is broadcast and when a soccer game is not carried out, service 1 is ceased (not included in the ensemble). Therefore, when

it is requested to enjoy a certain service, it is impossible to enjoy the service because this service is ceased.

[0010] Therefore, in the case where the service of the desired genre is retrieved and received using the program type as the keyword, it is thought that the routine 900 illustrated in Fig. 9, for example, is executed by a microcomputer.

[0011] Namely,

① When there is a frequency not received, such frequency is set as the receiving frequency (steps 902, 903).

② It is checked whether ensemble can be received or not (step 904).

③ When ensemble cannot be received as a result of ②, the receiving frequency is set to the next frequency (step 902).

④ When ensemble can be received as a result of ②, it is checked whether there is a service of the designated program or not (steps 911, 912).

⑤ When there is a service of the designated program type as a result of ④, such service is also selected (step 913).

⑥ When there is no service of the designated program type as a result of ④, the receiving frequency is set to the next frequency (step 902).

[0012] Therefore, according to this routine 900, the service of the target genre can be selected and received automatically.

[0013] However, in the routine 900 explained above, the process that ensemble is detected while seeking the frequency band of DAB and the service of target genre is retrieved for such ensemble is repeated to receive the service of target genre. As the frequency band of DAB, many ensembles are prepared.

[0014] Therefore, a very longer time is sometimes required until the service of target genre is received.

[0015] According to the present invention, there is provided a digital audio broadcasting receiver for broadcasting, with a broadcast signal, a plurality of program groups and program data of respective program contents of such program groups, wherein:

the history table of the frequency data for receiving the broadcast signal and such program data is provided,

the program data of the history table is retrieved, during reception of the broadcast, with the program data of program contents which are desired to be received,

the frequency data corresponding to the program data of detection result is extracted from the history table when the relevant program data is detected as a result of retrieval,

the receiving frequency is set to the frequency of the extracted frequency data, and

the program group of program contents which are

desired to be received is selected.

[0016] The target service is therefore retrieved from the history table of ensemble received in the past.

[0017] To allow better understanding the following description of embodiments of the present invention is given by way of non-limitative example with reference to the drawings, in which:

Fig. 1 is a block diagram illustrating the DAB receiver of an embodiment of the present invention.
Fig. 2 is a flowchart of an embodiment of the present invention.

Fig. 3 is a diagram for explaining the present invention.

Fig. 4 is a flowchart of the other embodiment of the present invention.

Fig. 5 is a flowchart of the other embodiment of the present invention.

Fig. 6 is a flowchart of the other embodiment of the present invention.

Fig. 7 is a hierarchy diagram for explaining the present invention.

Fig. 8 is a diagram for explaining the present invention.

Fig. 9 is a flowchart for explaining the present invention.

[0018] In Fig. 1, the broadcast signal of DAB is received with an antenna 11 and this receiving signal is supplied to a tuner circuit 12. This tuner circuit 12 is formed as the super-heterodyne system including PLL circuit. Therefore, the receiving frequency can be changed by changing a frequency dividing ratio N of the variable frequency dividing circuit of PLL. This tuner circuit 12 outputs a baseband signal of DAB and this baseband signal is supplied to an A/D converter circuit 13 for the purpose of A/D conversion to provide a digital signal.

[0019] This digital signal is supplied to an orthogonal demodulating circuit 14 and thereby the in-phase element (real axis element) and orthogonal element (imaginary axis element) are demodulated. These data are then subjected to the complex Fourier transformation in the fast Fourier transform (FFT) circuit 15 and the frequency element is output for each symbol. This output frequency element is supplied to a Viterbi decoder circuit 16 for the purpose of deinterleave and error correction and thereby the digital audio data of the target service component (program) can be selected.

[0020] Subsequently, the selected data is then supplied to an audio decoder circuit 17 for the purpose of decoding process such as MPEG data expansion and the decoder circuit 17 extracts the digital audio data of the target program. The extracted digital audio data is then supplied to the D/A converter circuit 18 for the purpose of conversion to the analog audio signals L, R through the D/A conversion and these signals R, L are

then supplied to the speakers 21L, 21R through the amplifiers 19L, 19R, thus enabling the listeners to listen the audio broadcasting.

[0021] Moreover, a microcomputer 31 for system control is also provided as control means and the data of frequency dividing ratio N of the variable frequency dividing circuit in PLL is supplied to the tuner circuit 12 from this microcomputer 31 as the frequency data for selecting ensemble (receiving frequency).

[0022] In addition, the data required for discriminating or identifying the service and service component, namely the data such as program type is extracted from the Viterbi decoder circuit 16 and this data is supplied to the microcomputer 31. Moreover, a selection signals SSV, SSC are supplied to the Viterbi decoder circuit 16 from the microcomputer 31 in order to select the service with the signal SSV and the digital audio data of the target service component is selected from the selected service with the signal SSC.

[0023] Moreover, the microcomputer 31 is provided, for example, with a retrieving and receiving routine 100 as illustrated in Fig. 2 as a part of the program to be executed in the microcomputer 31. For details of this routine 100, only the part in relation to this invention is illustrated in Fig. 2 as will be explained later.

[0024] Moreover, in this case, the microcomputer 31 is also provided with a memory 32. This memory 32 is formed, for example, of a flash memory or of a RAM, although not illustrated, which is provided with a battery for the back up purpose. Namely the memory 32 is formed of a non-volatile memory and thereby the written data is held even if the power supply is turned OFF.

[0025] This memory 32 is provided, as illustrated for example in Fig. 3, a history table HTBL indicating the history of ensembles received in the past. Namely, in this history table HTBL, a set of data is formed of the frequency dividing ratio N of the variable frequency dividing circuit in the PLL of the tuner circuit 12, ensemble ID and receiving time (date and time) as the data when the desired service is received and a plurality of these data are stored and held in this history table HTBL. In the case of Fig. 3, the frequency dividing ratio N1, ensemble ID (ENID01), receiving time TIME01 are held in the first line as the data when a program of a certain DAB station is received.

[0026] Moreover, the microcomputer 31 is connected with a clock circuit 33 for clocking the current time. In addition, it is also connected with various manipulation keys 34 formed, for example, of a push switch and is also connected with a display element, for example, LCD35 to display various pieces of information.

[0027] In the structure explained above, when the service is received by selecting the ensemble with the manual manipulation, the history table HTBL is updated. Namely, when the ensemble selected by the key manipulation is not included in the history table HTBL, a set of data of frequency dividing ratio N,

ensemble ID and time indicated by the clock circuit 33 is added to the history table HTBL. In addition, when the ensemble selected by the key manipulation is included in the history table HTBL, the receiving time (receiving time of the same line) pairing a set with the frequency dividing ratio N in the history table HTBL is updated to the current time clocked by the clock circuit 33.

[0028] Accordingly, the frequency dividing ratio N, ensemble ID and receiving time of the final reception are registered for the ensemble received in the past in the history table HTBL. This history table HTBL is sorted, when contents thereof are updated, so that a set of the data of the latest receiving time is defined as the first set of data.

[0029] When the menu key among the manipulation keys 34 is depressed, a menu is displayed on the LCD35. Therefore, when a cursor is moved to the "reception by genre" among the menu items with a cursor key and then a determination key is depressed, genre such as "classical music", "rock music", "pops", "news" is displayed on the LCD35.

[0030] Here, when the cursor is moved to the target genre and the determination key is depressed, the program indicating the genre on which the cursor is located is once stored in the microcomputer 31.

[0031] Subsequently, the process in the microcomputer 31 is started from the step 101 of the routine 100 and it is next determined in the step 102 whether reception is executed or not for all frequency dividing ratios N registered in the history table HTBL. When reception is executed for all frequency dividing ratios N, the process goes to the step 103 from the step 102. In the step 103, the frequency dividing ratio N of the frequency not received in the history table HTBL is read from the history table HTBL and is then set to the tuner circuit 12, namely the receiving frequency is set.

[0032] Subsequently, in the step 104, it is determined whether the ensemble can be received or not in the current receiving frequency. If, the ensemble cannot be received, the process returns to the step 102 from the step 104. Accordingly, the processes from the step 102 to the step 104 are repeated until the ensemble can be received. In this case, ensemble is updated.

[0033] When it is determined in the step 104 that the ensemble can be received in the current receiving frequency, the process goes to the step 111 from the step 104. In this step 111, the history table HTBL is updated. In this case, the receiving time forming a pair with the frequency dividing ratio N (frequency dividing ratio N set in the step 103) giving the current receiving frequency of the history table HTBL is updated to the current time clocked by the clock circuit 33.

[0034] Next, it is retrieved in the step 112 whether the service of target genre is included or not in the service of the ensemble being received. In this case, this retrieval is executed by checking whether the program type once registered in the microcomputer 31 immediately before execution of this routine 100 is included or

not in the ensemble being received.

[0035] When it is determined that the result of this retrieval is determined in the step 113 to prove that the service of the target genre is not included in the ensemble being received, the process returns to the step 102 from the step 113. Therefore, the processes from the step 102 to the step 103 are repeated until the service of the target genre is included in the ensemble being received. In this case, the ensemble is updated.

[0036] When the service of the target genre is included in the ensemble being received in the step 113, it is detected in the step 113 and the process goes to the step 121 from the step 113. In the step 121, the selection signal SSV for designating the service of target genre (service of the program type once registered in the microcomputer 31 immediately before execution of this routine 100) and the selection signal SSC for designating the first service component, for example, in this service are supplied to the Viterbi decoder circuit 16 for the purpose of service selection and the service component is also selected. Thereafter, this routine 100 is completed in the step 122.

[0037] Therefore, from the timing of the execution of step 121, the target genre can be selected and received and thereby a program of the target genre can be received.

[0038] When reception is executed for all frequency dividing ratios N registered in the history table HTBL in the step 102, the process goes to the step 131 from the step 102. In this step 131, it is displayed, for example, on the LCD35 that the service of the target genre is not yet transmitted in current. Thereafter, the routine 100 is completed in the step 122.

[0039] As explained above, according to the DAB receiver of Fig. 1, since the service of target genre is retrieved by receiving the ensemble which has been once received, the service of the target genre can be received within a short period of time.

[0040] Fig. 4 is the flowchart of the process in which the service of the target genre is retrieved with the ensemble not registered in the history table HTBL in such a case that service of the target genre cannot be received in the ensemble registered in the history table HTBL.

[0041] Namely, the process up to the step 122 from the step 102 is structured like the routine 100 of Fig. 2 even in the routine 200 of Fig. 4. Therefore, when service of the target genre is included in the ensemble registered in the history table HTBL, this service can be received within a short period of time as explained above.

[0042] However, if service of the target genre is not included in the ensemble registered in the history table HTBL, it is determined in the step 102 and the process goes to the step 241 from the step 102. In the step 241, it is determined whether there is a frequency dividing ratio N which is not yet registered in the history table HTBL and is never executed for retrieval of service.

[0043] When there is a frequency dividing ratio N which is never executed for retrieval of service, the process goes to the step 242 from the step 241. In this step 242, the frequency dividing ratio N which is not yet executed for retrieval of service is set to the tuner circuit 12 and thereafter the process goes to the step 104.

[0044] Therefore, even in the case of the frequency of the frequency dividing ratio N not registered in the history table HTBL, if the ensemble is transmitted with inclusion of service of the target genre, the service is thereafter received with such ensemble to enjoy the program of this service.

[0045] In this case, the history table HTBL is updated in the step 111 and a set of frequency dividing ratio N, ensemble ID and time indicated by the clock circuit 33 is added to the history table HTBL.

[0046] Moreover, if service of the target genre cannot be received even in the frequency of the frequency dividing ratio N not registered in the history table HTBL, the process goes to the step 251 from the step 241. In the step 251, it is displayed, for example, on the LCD35 that service of the target genre is not yet transmitted in current and thereafter the routine 200 is completed in the step 122.

[0047] Thereafter, according to this routine 200, since the ensemble which has been once received is retrieved preferentially and all ensembles are retrieved, the retrieval process can surely be executed within a short period of time.

[0048] Meanwhile, it is possible for DAB to transmit the program type of the service in the other ensemble as the data of the other broadcast station. Therefore, in the retrieving and receiving routine 300 illustrated in Fig. 5, when such data is transmitted, such data can also be used.

[0049] Namely, in the routine 300, the process up to the step 251 from the step 101 is structured like those in the routine 200, the step 301 is provided between the step 101 and step 102. In the step 301, it is determined whether the program type of service of the other ensemble is transmitted or not.

[0050] During the transmission of signal, the process goes to the step 302 from the step 301. In this step 302, it is retrieved whether there is a program type of the target service in the program type of the service in the other ensemble being transmitted. When there is a program type of the target service, the process goes to the step 303 from the step 302. In the step 302, the receiving frequency is set to the ensemble including the target service and thereafter the process goes to the step 104. Subsequently, the retrieval and reception of the target service are executed.

[0051] Moreover, in the step 301, when the program type of the service in the other ensemble is not transmitted and when there is no program type of the target service in the program type of the service in the other ensemble transmitted in the step 302, the process goes to the step 102 from the step 301 or 302 and thereafter

the retrieval process is executed as explained above.

[0052] In this case, when the ensemble cannot be received in the step 104, the process returns to the step 301 from 104. Moreover, in the step 113, when service of the target genre is not included in the receiving ensemble, the process returns to the step 301 from the step 113.

[0053] As explained above, according to the routine 300, when the program type of the service in the other ensemble is transmitted as the data of the other station, retrieval and reception of the target service are executed using such data and therefore the target service can be received within a shorter period of time.

[0054] In the retrieval and receiving routine 400 illustrated in Fig. 4, when the target service is retrieved and received, a user can select the first retrieval and receiving mode only for the ensemble registered in the history table HTBL and also can further select the second retrieval and receiving mode for retrieving the ensemble not registered in the history table HTBL in such a case that the target service cannot be received in this retrieval and receiving mode.

[0055] Namely, in this case, a user previously sets by manipulating the key 34 that retrieval should be done with any mode of the first retrieval and receiving mode and second retrieval and receiving mode. Thereby, when the routine 400 is executed, the process goes to the step 401 after the step 101. In the step 401, it is determined that the retrieval and receiving mode is set to the first retrieval and receiving mode or second retrieval and receiving mode.

[0056] When the retrieval and receiving mode is set to the first retrieval and receiving mode, the process goes to the step 102 of the routine 100 from the step 401. When the retrieval and receiving mode is set to the second retrieval and receiving mode, the process goes to the step 102 of the routine 200 from the step 401.

[0057] Therefore, according to the routine 400, when the retrieval and receiving mode is set to the first retrieval and receiving mode depending on the object of user, the target service can be received within a shorter period of time and when it is set to the second retrieval and receiving mode, a certain time may be required for reception but the target service can surely be received. Accordingly, data receiving can be realized depending on the condition which a user desires.

[0058] When the receiving frequency is set to the ensemble registered in the history table HTBL in the routines 100 to 400, if such ensemble cannot be received, a set of data regarding such ensemble may be deleted from the history table HTBL.

[0059] According to the present invention, the broadcasting of the target genre can be searched for and listened to within a short period of time. Moreover, it can surely be retrieved. In addition, the broadcast of the target genre can surely be received within a short period of time depending on the object of user.

Claims

1. A digital audio broadcasting receiver for broadcasting a plurality of program groups and program data showing program contents in each group among a plurality of said program groups with one broadcast signal, 5
wherein frequency data for receiving said broadcast signal and history table of said program data are included, 10

control means retrieves said data of said history table by the program data of program contents which are desired to be received during the reception of the broadcast, 15
extracts the frequency data corresponding to the program data from said history table when the relevant program data is detected as a result of said retrieval, and
sets the receiving frequency to the frequency 20
indicated by the extracted frequency data and selects the program group of the program contents which is desired to be received.

2. A digital audio broadcasting receiver as claimed in claim 1, wherein control means retrieves said data included in said broadcast signal with the data of said program contents which are desired to be received for the broadcast signal not registered in said history table among said broadcast signals on the broadcast band when said relevant program data is not detected as a result of said retrieval and receives the broadcast of the receiving frequency and selects the program group of program contents which are desired to be received when the relevant program data is detected as a result of said retrieval. 25
30
35

3. A digital audio broadcasting receiver for broadcasting a plurality of program groups and program data showing program contents in each group among a plurality of said program groups with one broadcast signal, 40
wherein frequency data for receiving said broadcast signal and history table of said program data are included; 45
when the first receiving mode is set, control means retrieves said program data of said history table with the program contents which are desired to be received, extracts the frequency data corresponding to the program data of detection result from said history table when the relevant program data is detected as a result of said retrieval, sets the receiving frequency to the frequency of said extracted frequency data and selects the program group of program contents which are desired to be received; and 50
55
when the second receiving mode is set, control

means retrieves said data included in a broadcast signal with the data of program contents which are desired to be received for the broadcast signal not registered in said history table among said broadcast signals on the broadcast band when said relevant program data is detected as a result of said retrieval and receives the broadcast of the receiving frequency and selects the program group of the program contents which are desired to be received when the relevant program data is detected as a result of said retrieval.

FIG. 1

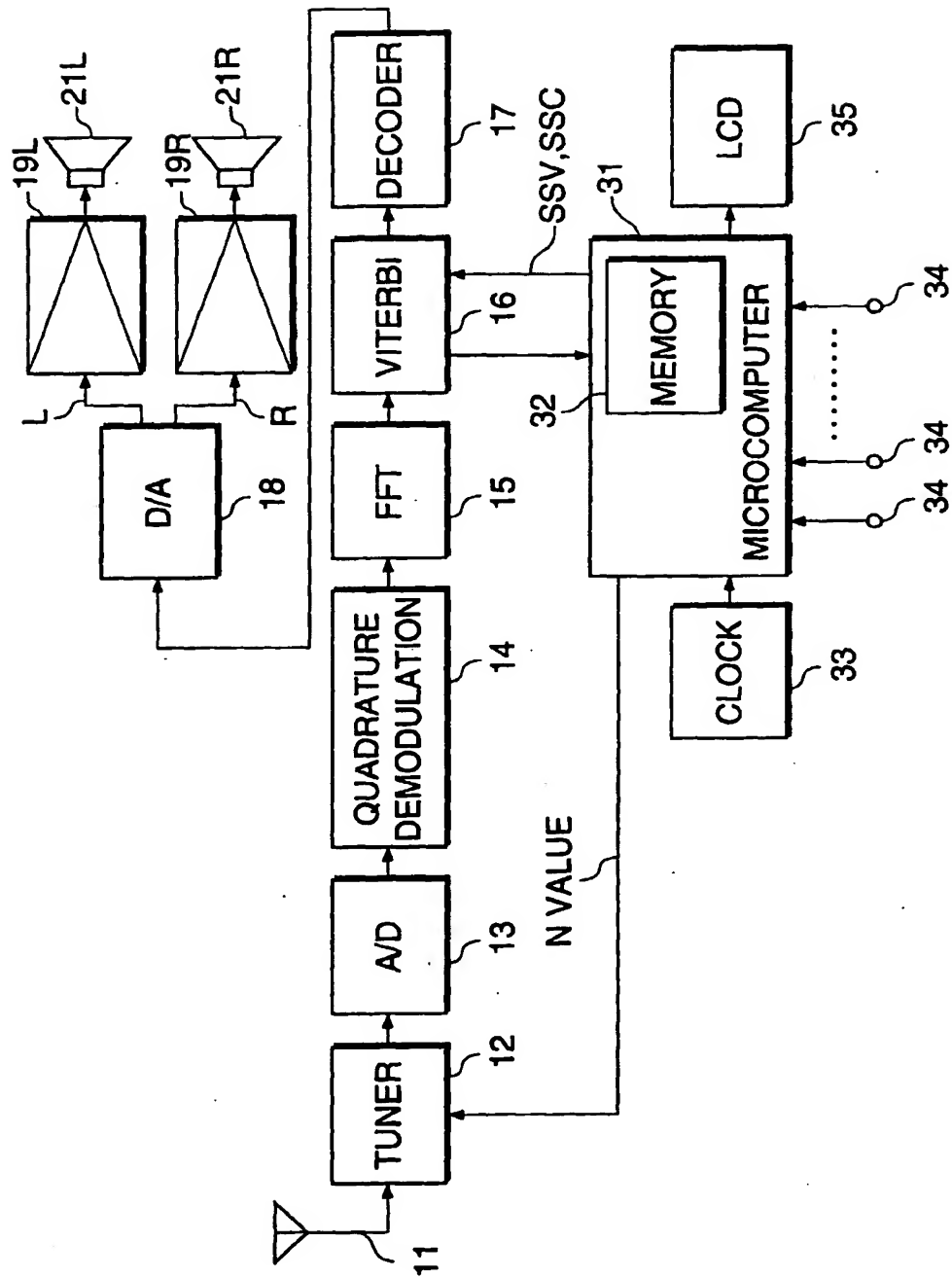


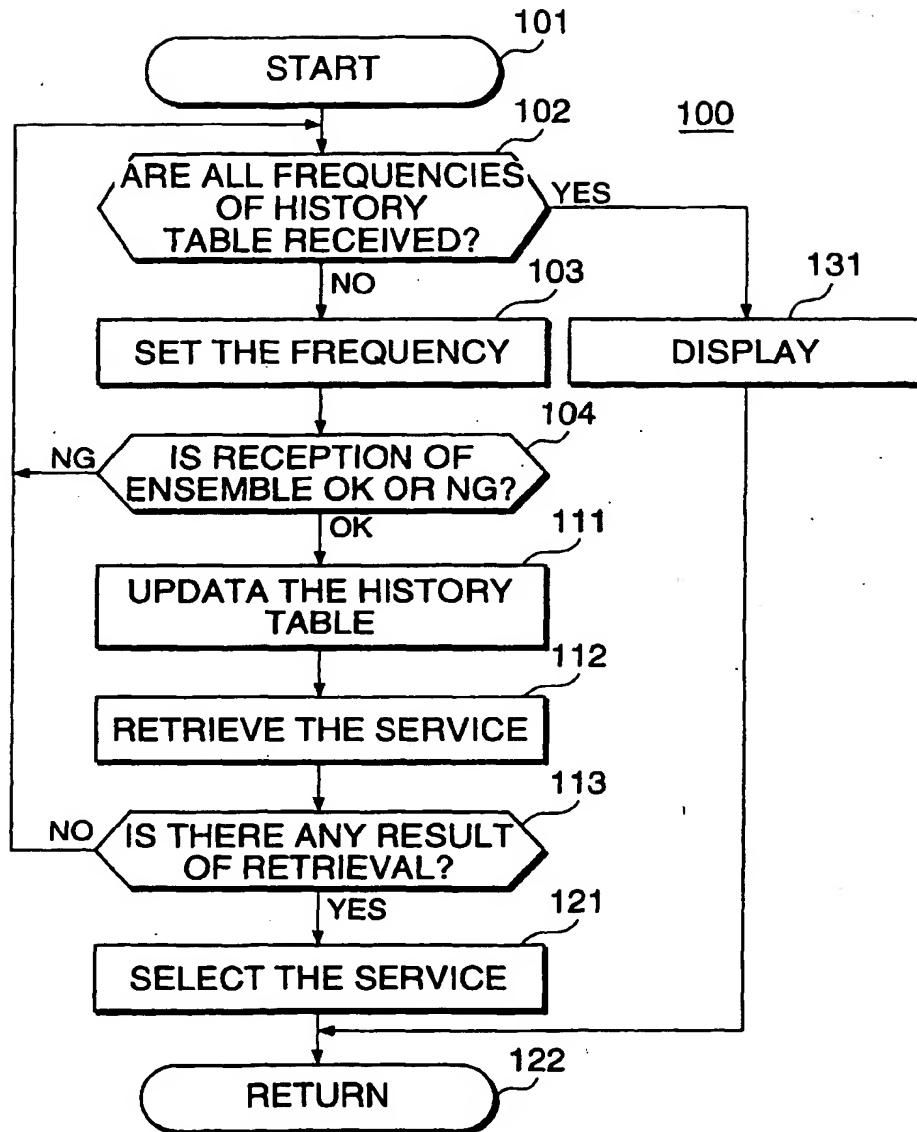
FIG.2

FIG.3

N VALUE	ENSEMBLE ID	RECEIVING TIME
N1	ENID01	TIME01
N2	ENID02	TIME02
N3	ENID03	TIME03
N4	ENID04	TIME04
⋮	⋮	⋮

HISTORY TABLE HTBL

FIG. 4

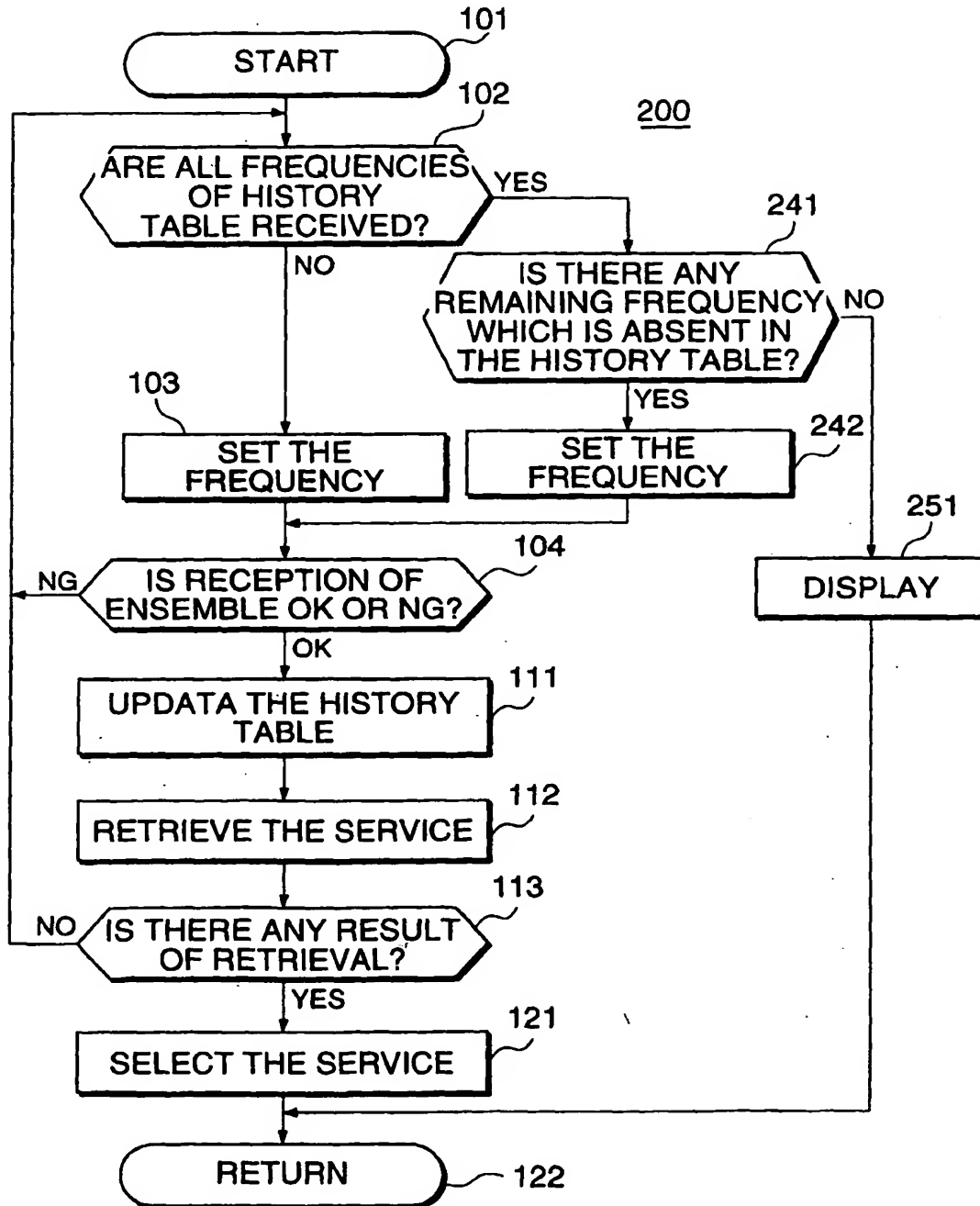


FIG.5

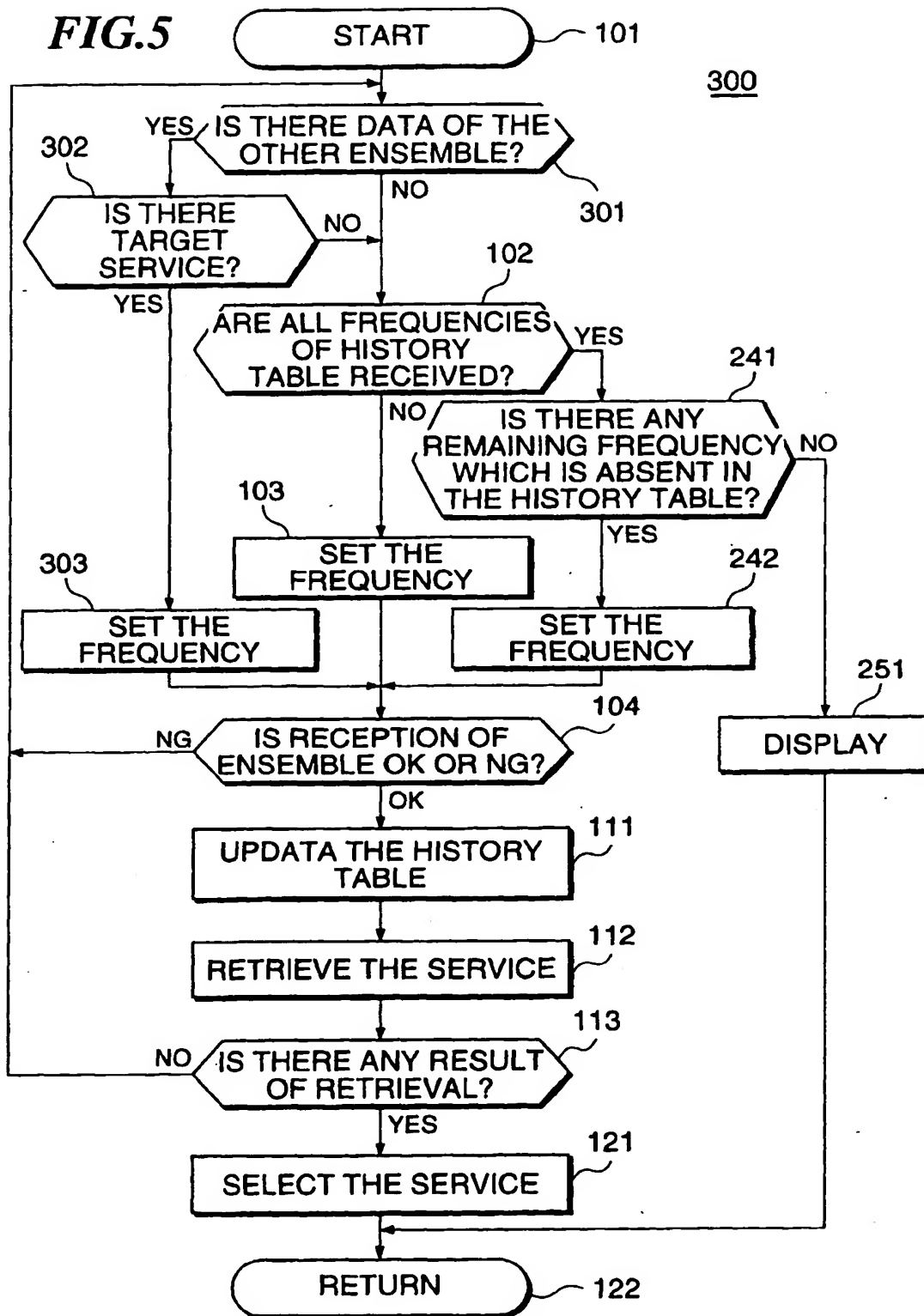


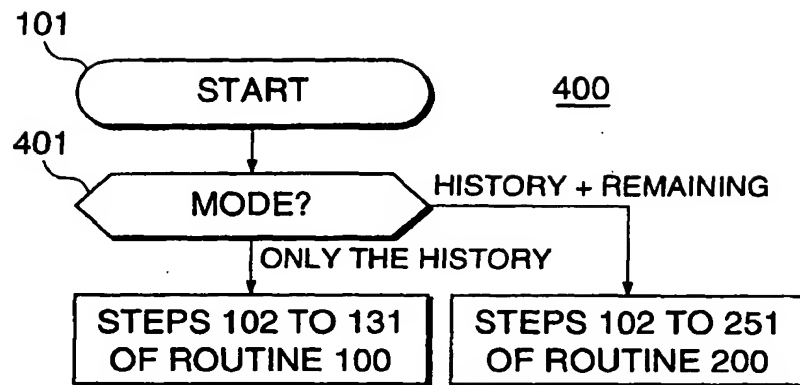
FIG.6

FIG.7

ENSEMBLE	ENSEMBLE A (ENSEMBLE ID)			
	SERVICE 1 (PROGRAM TYPE)	SERVICE 2 (PROGRAM TYPE)	SERVICE 3 (PROGRAM TYPE)	SERVICE 4 (PROGRAM TYPE)
SERVICE COMPONENT	PROGRAM 1A (SERIAL NO.1)	PROGRAM 2A (SERIAL NO.1)	PROGRAM 3A (SERIAL NO.1)	PROGRAM 4A (SERIAL NO.1)
	PROGRAM 1B (SERIAL NO.2)	PROGRAM 2B (SERIAL NO.2)	PROGRAM 3B (SERIAL NO.2)	PROGRAM 4B (SERIAL NO.2)
	PROGRAM 1C (SERIAL NO.3)	PROGRAM 2C (SERIAL NO.3)	PROGRAM 3C (SERIAL NO.3)	
	PROGRAM 1D (SERIAL NO.4)		PROGRAM 3D (SERIAL NO.4)	
	PROGRAM 1E (SERIAL NO.5)		PROGRAM 3E (SERIAL NO.5)	

FIG.8

SERVICE	PROGRAM TYPE
SERVICE 1	CLASSIC
SERVICE 2	ROCK
SERVICE 3	POPS
SERVICE 4	NEWS

FIG.9